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The Cause of the Great Inflation: Interactions Between the Government and the Monetary Policymakers

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ABSTRACT

The paper offers a new explanation for the cause of the Great Inflation by constructing a model that explicitly separates the roles of government and monetary policymakers. A mechanism that inflation can accelerate even if an inflation target is low is uncovered. The model solves the puzzle of the observed high inflation target during the Great Inflation and indicates that the policy errors at the time were not solely attributed to the monetary policymakers but made in the process of interaction between the governments and the monetary policymakers. The model is consistent with the international aspect of the Great Inflation.

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I. INTRODUCTION

Studying the Great Inflation in the 1960s and the 1970s seems still very important even in the current low-inflation environment because such a grim economic situation should be avoided forever. To take proper measures to avoid a resurgence of chronic high inflation in future, the true cause of the Great Inflation should be identified. There are many explanations for the cause of the Great Inflation, and most of them seem to be classified into the following several views.

(i) *The bad luck view:* This view attributes the cause of the Great Inflation to exogenous large shocks that were not related to policies.[1] However, the chronic high inflation in the 1960s and the 1970s was so exceptional and persisted so long that it is hard to identify exogenous large shocks that were reconciled with the exceptional movement of inflation at the time. Some argue that two oil price shocks in the 1970s triggered the Great Inflation. However, others offer a counterargument that, although the oil price shocks may have played important roles to some extent, they alone can not fully explain the Great Inflation because it was already underway in the late 1960s.[2]

(ii) *The time inconsistency view:* Kydland and Prescott (1977) and Barro and Gordon (1983) argue that the lack of commitment is the main cause of the Great Inflation. This view is recently emphasized again by Chari, Christiano and Eichenbaum (1998).[3] They contend that if monetary policy makers are unable to fully commit to policies, they find themselves in a sub-optimal equilibrium. It implies a possibility that the Great Inflation was caused by the lack of commitment. A typical explanation based on this view is that, as post-World War II baby boomers entered the workforce, the natural rate of unemployment rose in the 1960s and the 1970s and declined in the 1980s, and thus if the monetary policy makers were not able to fully commit their policies, inflation rose in the 1960s and the 1970s and

declined in the 1980s. A problem of this view is that this view needs a series of negative and persistent supply-side shocks that worked to increase the natural rate of unemployment to explain the Great Inflation. Hence, as Ireland (1999) and Taylor (2002) argue, it is hard to explain the Great Inflation in Europe by the same mechanism as the U.S. because the demographic change in Europe was different from that in the U.S. and the movement of the natural rate of unemployment differed between them.[4] In addition, it is difficult to explain the sharp decline of inflation in the 1980s by a demographic change that usually proceeds gradually. Another difficulty with this view is that it predicts that unemployment leads inflation but unemployment usually lags inflation and thus this view is clearly at odds with the data. Finally, this view contends that the monetary policy makers in those days were insincere for a long period of time because they did not commit their policies. They may have been actually insincere but many will doubt whether they were really insincere for a long period of time because they were the best and brightest people in those days.

(iii) *The policy mistakes views:* This view stresses that the monetary policy makers at the time were not as good as the ones after the 1980s. There are two versions of the policy mistakes view.

(a) *The weak response view:* It is argued by this view that the monetary policy makers in the 1960s and the 1970s were less responsive to inflationary pressures and it is the main cause of the Great Inflation. A typical model of this view is the model in Clarida, Gali, and Gertler (2000). They argue that the model with a forward-looking Phillips curve predicts that the weak response of monetary policy makers to inflationary pressures generates excessive volatilities of inflation and thus this mechanism has a possibility to have generated the Great Inflation. However, Christiano and Gust (2000) criticize Clarida *et al*., (2000) for inconsistence with the observed stagflation of the time because the model in Clarida *et al*., (2000) predicts that the rise in inflation triggered by a bad supply shock is associated with a sustained rise in employment. Another weak point of the model of Clarida *et al*., (2000) is that it depends on forward-looking Phillips curves but forward-looking Phillips curves are criticized for not being able to explain the persistent nature of inflation.[5] Furthermore, like the time inconsistency view, this view has a weak point that it needs to contend the monetary policy makers' insincerity or foolishness because they continued to take clearly inferior policies.[6]

(b) *The misperception view:* Orphanides (2002, 2003) argues another type of policy mistakes. He contends that the potential GDP was overestimated and correspondingly the full-employment unemployment rate was underestimated and thereby monetary policy makers wrongly took over-expansionary monetary policies. However, Taylor (2002) argues that the potential GDP series that Orphanides (2002, 2003) uses was recognized at the time by the monetary policy makers to be flawed and thus this view exaggerates the size of the policy error. Furthermore, models based on this view usually show that the contribution of the overestimate of potential GDP to the Great Inflation is not high and thus an additional mechanism is needed to fully explain the Great Inflation.[7] In addition, this view has the same weak point as other views that it needs to contend that the monetary policy makers in those days were foolish for a long period of time.

The above views, at first glance, appear very different each other, but they have some common features. First, except the bad luck view, they commonly argue that the monetary policy makers in the 1960s and 1970s continued to be insincere or foolish for a long period of time. However, a simple question may be raised: were they actually insincere or foolish for a long period of time? They may actually have been so, but they were the best and brightest people at the time. Many therefore will not be convinced completely by the explanations that assume merely their insincerity or foolishness unless the reason why they continued to take such insincere or foolish policies is explained.

Particularly, there is a serious question why the monetary policy makers in the 1970s set high target rates of inflation. Clarida *et al*., (2000), Favero and Rovelli (2001) and Dennis (2001) conclude that the target rate of inflation in the pre-Volker era was much higher than that in the Volker-Greenspan era. Setting a high inflation target is completely different from making other policy mistakes. It implies that monetary policy makers do not wish low inflation and intentionally pursue high inflation. It looks like a kind of crime. Any of the above views seems unable to offer a reasonable explanation other than arguing that the monetary policy makers deliberately committed a crime of high inflation. Nevertheless, it is not an easily acceptable argument. Probably there are some unavoidable reasons that are not explained well by the above views, by which the monetary policy makers were forced to raise the target rate of inflation unwillingly.

The second common feature of the above views is that, except the misperception view, they need exceptionally large or successive negative supply shocks. It is a serious problem because the Great Inflation was not limited in the U.S. but observed simultaneously in most industrialized countries. Thereby, those views need internationally common exceptionally large or successive negative supply shocks to explain the international aspect of the Great Inflation. However, a simple question may be raised again: what were actually these shocks? The oil price shocks in the 1970s do not seem to be such shocks because the Great Inflation was already underway in the mid 1960s. As was argued about shocks that the time inconsistency view needs, demographic changes were different across countries. It seems hard to identify these shocks. Hence those views have a serious weak point that they can not explain the international aspect of the Great Inflation.

The paper explores a different possibility of explanation for the Great Inflation to answer these questions. Unlike the aforementioned views, the paper does not assume an exceptional situation *a priori*. Instead, the paper explicitly separates the roles of a government and monetary policy makers and constructs a model that explicitly incorporates the preference of government, and analyzes the process of decision makings through interactions between them during the Great Inflation. The model indicates that inflation can accelerate even if an exceptional situation is not assumed. Unlike conventional models in which there is no possibility of the acceleration of inflation for any target rate of inflation unless an exceptional situation is assumed, there is a possibility that inflation accelerates for a range of inflation target, *i.e*., inflation can accelerate even if inflation target is low. This possibility is the most important finding in the paper and plays the key role in the explanation for the cause of the Great Inflation. Through the analyses of this acceleration mechanism of inflation, it is argued that the Great Inflation was a consequence of policy errors that were made in the process of interaction between the governments and the monetary policy makers.

The paper is organized as follows. In section II, a conventional discrete-time model with a backward-looking Phillips curve is constructed and the preference of government is explicitly added to the model. In section III, the condition for the acceleration of inflation is examined by the model. It is shown that inflation accelerates despite a low inflation target. In section IV, the cause of the Great Inflation is examined by the model. The model indicates that (i) the monetary policy makers initially made an honest mistake to set a slightly higher inflation target, (ii) they were forced to raise inflation target unwillingly, and (iii) the governments were made hesitant to drastically change policies. In section V, it is argued that the explanation has three appealing features. Finally some concluding remarks are offered in section VI.

II. THE MODEL

1. A Conventional Model

To begin with, a conventional discrete-time model is constructed. This model is based on a backward-looking Phillips curve type model examined in Svensson (2003). It consists of an aggregate supply function, an aggregate demand function and a Taylor type instrument rule for monetary policy makers.

- The aggregate supply function (Phillips curve):

$$\pi_{t+1} = \pi_t + \alpha_x x_t + \alpha_z z_{t+1} + \varepsilon_{t+1}, \tag{1}$$

- The aggregate demand function:

$$x_{t+1} = \beta_x x_t + \beta_z z_{t+1} + \beta_r (r_t - \bar{r}) + \eta_{t+1} \tag{2}$$

- The Taylor type instrument rule for monetary policy makers:

$$i_t = \bar{\gamma} + \gamma_\pi (\pi_t - \pi^*) + \gamma_x x_t, \tag{3}$$

where π_t is the rate of inflation, x_t is the output gap, z_t is a column vector of exogenous variables, r_t is the short real interest rate, $\bar{r}$ is the average short real interest rate, i_t is the short nominal interest rate, π^* is the target rate of inflation, α_x, α_z, β_x, β_r, $\bar{\gamma}$, γ_π and γ_x are constant coefficients, α_z and β_z are row vectors of constant coefficients, ε_t and η_t are i.i.d. shocks with zero mean, and $\varepsilon_0 = 0$ and $\eta_0 = 0$. Here, $\bar{\gamma} = \pi^* + \bar{r}$ as is usually assumed and the short real interest rate is defined as follows;

$$r_t \equiv i_t - \pi_{t+1|t}, \tag{4}$$

where $\pi_{t+1|t}$ means the rate of inflation in period $t+1$ expected in period t, and it is assumed that $r_{t+1|t} = \bar{r}$ for any s ($s = 1, 2, 3, \ldots$).

2. An Extended Model that Explicitly Incorporates the Preference of Government

An essential difference between government and monetary policy makers is that a government has political objectives while monetary policy makers basically have only economic objectives. To construct a model that explicitly separates the roles of government and monetary policy makers in inflation, this difference needs to be explicitly incorporated. The paper particularly combines the above conventional model with the model examined in Harashima (2004) (see Appendix) that explicitly incorporates the preference of a government that pursues its political objectives, *e.g.*, strengthening national security, improving social welfare, or enhancing national prestige. The law of motion for inflation in this model is $\dot{\pi}_t = 2(\theta^G - \theta^P)$ in a continuous time

model and $\pi_{t+1} = \pi_t + 2(\theta^G - \theta^P)$ in a discrete time model where θ^G and θ^P are the rates of time preference of a government and households respectively (a microfoundation of the equation is shown in Appendix). Thus the preference of government θ^G is explicitly incorporated in this model. At the equilibrium in markets with random shocks, an equation $r_t = \theta^P + \mu_t = \overline{r} + \mu_t$ holds where μ_t is i.i.d. shocks with zero mean and $\mu_0 = 0$. Hence, the law of motion for inflation $\pi_{t+1} = \pi_t + 2(\theta^G - \theta^P)$ can be rewritten as $\pi_{t+1} = \pi_t + 2(\theta^G - \overline{r} - \mu_t)$ and thus in a discrete time model with random shocks,

$$\pi_{t+1} = \pi_0 + 2(\theta^G - \overline{r})(t+1) - 2\sum_{v=1}^{t+1} \mu_v + \xi_{t+1}, \tag{5}$$

where π_0 is π_t in period 0 and means a steady state inflation rate before a shock on π^*, and ξ_t is an i.i.d. shock with zero mean and $\xi_0 = 0$. The model in the paper includes this equation (5) in addition to equations (1), (2), (3) and (4).

The inclusion of equation (5) implies that either the target rate of inflation π^* or the preference of government θ^G is a time-variable endogenous variable. That is, in the extended model that includes equation (5), not only the behavior of monetary policy makers but the behavior of a government is considered, and the mechanism of inflation is explained by interactions between the government and the monetary policy makers. It is a great advantage of the model over other models. Governments have been considered to play an important role in inflation but most models do not explicitly consider the behavior of government but only include loss functions of monetary policy makers. In those models, the role of government is not explicitly separated from the role of monetary policy makers and the relation between them is left ambiguous. As a result, interactions between them in the process of inflation are unclear.

Conflicts between them under the surface of water may result in policy errors but in those models, these errors are solely attributed to monetary policy makers. Most explanations mentioned in introduction need unbelievably insincere or foolish monetary policy makers, but behind their insincerity or foolishness, there seems to be complex interactions between the governments and the monetary policy makers. Hence, a more realistic explanation will be possible if the motives of both of them are considered separately. The model in the paper explicitly separates the roles of government and monetary policy makers by including equation (5) and analyzes the process of decision makings through interactions between them during the Great Inflation.

III. THE CONDITION FOR THE ACCELERATION OF INFLATION

1. The Acceleration of Inflation in the Conventional Model

Before examining the model with equation (5), the conventional model that does not include equation (5) is examined to more lucidly understand the nature of the model with equation (5). The conventional model without equation (5) consists of four equations (1), (2), (3) and (4). By equations (3) and (4),

$$\pi_t = \pi^* + \frac{1}{\gamma_\pi}(r_t + \pi_{t+1|t}) - \frac{\gamma_x}{\gamma_\pi} x_t - \frac{\overline{\gamma}}{\gamma_\pi}, \tag{6}$$

and by equations (1) and (6), $\pi_t = \pi^* + \dfrac{r_t + \pi_t + \alpha_x x_t + \alpha_z z_{t+1|t} - \overline{\gamma} - \gamma_x x_t}{\gamma_\pi}$. Thereby

$$x_t = \frac{1}{\alpha_x - \gamma_x}[(\gamma_\pi - 1)\pi_t - \gamma_\pi \pi^* - r_t + \overline{\gamma} - \alpha_z z_{t+1|t}]. \quad (7)$$

By equations (2) and (7),

$$(\gamma_\pi - 1)\pi_{t+1} - \gamma_\pi \pi^* - r_{t+1} + \overline{\gamma} - \alpha_z z_{t+2|t+1} = \beta_x[(\gamma_\pi - 1)\pi_t - \gamma_\pi \pi^* - r_t + \overline{\gamma} - \alpha_z z_{t+1|t}] + (\alpha_x - \gamma_x)[\beta_z z_{t+1|t} - \beta_r(r_t - \overline{r}) + \eta_{t+1}]. \quad (8)$$

Hence

$$\pi_{t+1} = \beta_x \pi_t + \frac{(1-\beta_x)(\gamma_\pi \pi^* - \overline{\gamma}) + r_{t+1} + \alpha_z z_{t+2|t+1} - \beta_x(r_t + \alpha_z z_{t+1|t}) + (\alpha_x - \gamma_x)[\beta_z z_{t+1|t} - \beta_r(r_t - \overline{r}) + \eta_{t+1}]}{\gamma_\pi \ 1}.$$

For simplicity, it is assumed that the exogenous variables z_t play limited roles for inflation and output gaps and thus α_z, β_z are near zero and approximately $\alpha_z(z_{t+2|t+1} - \beta_z z_{t+1|t}) + (\alpha_x + \gamma_x)\beta_{z\,zt+1|t} = 0$.

Thereby,

$$\pi_{t+1} = \beta_x \pi_t + \frac{(1-\beta_x)(\gamma_\pi \pi^* - \overline{\gamma}) + r_{t+1} - \beta_x r_t - (\alpha_x - \gamma_x)[\beta_r(r_t - \overline{r}) - \eta_{t+1}}{\gamma_\pi - 1}. \quad (9)$$

Because $r_{t+s|t} = \overline{r}$ and $\eta_{t+s|t} = 0$ for any s (s = 1, 2, 3, …) by assumption, then by equation (9),

$$\lim_{s \to \infty} \pi_{t+s|t} = \frac{\gamma_\pi \pi^* - \overline{\gamma} + \overline{r}}{\gamma_\pi - 1}.$$

Because $\overline{\gamma} = \pi^* + \overline{r}$,

$$\lim_{s \to \infty} \pi_{t+s|t} = \pi^*. \quad (10)$$

Equation (10) indicates that, as is well known, the rate of inflation converges at the target rate of inflation in conventional models.

The important implication of equation (10) is that inflation never accelerate for any inflation target π^* in case that a conventional model is used. Conversely, equation (10) implies that, to explain the cause of the Great Inflation by a conventional model, an exceptional situation needs to be assumed. It is the reason why any view on the Great Inflation argued in introduction assumes an exceptional situation.

2. The Acceleration of Inflation in the Extended Model

The model with equation (5) is examined. Equation (8) is common to both model with equation (5) and conventional model without equation (5). By equation (5) and equation (8),

$$(\gamma_\pi - 1)\left[\pi_0 + 2(\theta^G - \overline{r})(t+1) - 2\sum_{v=1}^{t+1}\mu_v + \xi_{t+1}\right] - \gamma_\pi \pi^* - (\overline{r} + \mu_{t+1}) + \overline{\gamma} - \alpha_z z_{t+2|t+1} =$$

$$\beta_x\left\{(\gamma_\pi - 1)\left[\pi_0 + 2(\theta^G - \overline{r})t - 2\sum_{v=0}^{t}\mu_v + \xi_t\right] - \gamma_\pi \pi^* - (\overline{r} + \mu_t) + \overline{\gamma} - \alpha_z z_{t+1|t}\right\} + (\alpha_x - \gamma_x)(\beta_z z_{t+1|t} - \beta_r \mu_t + \eta_{t+1}),$$

because $\pi_t = \pi_0 + 2(\theta^G - \overline{r})\, t - 2\sum_{v=0}^{t} \mu_v + \xi_t$ by equation (5). Thereby,

$$2(\gamma_\pi - 1)\,(t + 1 - \beta_x t)\theta^G = [2(\gamma_\pi - 1)(t + 1 - \beta_x t) + (1 - \beta_x)\overline{r} + (1 - \beta_x)[\gamma_\pi \pi^* - \overline{\gamma} - (\gamma_\pi - 1)\,\pi_0]$$
$$+ (\gamma_\pi - 1)\left(2\sum_{v=1}^{t+1} \mu_v - \xi t + 1\right) + \mu_{t+1} + \alpha_z z_{t+2\,|\,t+1}$$
$$-\beta_x\left[(\gamma_\pi - 1)\left(2\sum_{v=0}^{t} \mu_v - \xi_t\right) + \mu_t + \alpha_z z_{t+1|t}\right] + (\alpha_x - \gamma_x)(\beta_z z_{t+1|t} - \beta_r \mu_t + \eta_{t+1}),$$

and thus

$$\theta^G - \overline{r} = \frac{(1-\beta_x)[\overline{r} + \gamma_\pi \pi^* - \overline{\gamma} - (\gamma_\pi - 1)\pi_0}{2(\gamma_\pi - 1)(t + 1 - \beta_x t)}$$
$$+ \frac{(\gamma_\pi - 1)\left(2\sum_{v=1}^{t+1} \mu_v - \xi_{t+1}\right) + \mu_{t+1} + \alpha_z z_{t+2|t+1} - \beta_x\left[(\gamma_\pi - 1)\left(2\sum_{v=0}^{t} \mu_v - \xi_t\right) + \mu_t + \alpha_z z_{t+1|t}\right]}{2(\gamma_\pi - 1)(t + 1 - \beta_x t)}$$
$$+ \frac{(\alpha_x - \gamma_x)(\beta_z z_{t+1|t} - \beta_r \mu_t + \eta_{t+1})}{2(\gamma_\pi - 1)(t + 1 - \beta_x t)}.$$

Like the conventional model, it is assumed for simplicity that the exogenous variables z_t play limited roles for inflation and output gaps and thus α_z, β_z are near zero and approximately $\alpha_z(z_{t+2\,|\,t+1} - \beta_x z_{t+1\,|\,t}) + (\alpha_x + \gamma_x)\,\beta_z z_{t+1\,|\,t} = 0$. Thereby

$$\theta^G - \overline{r} = \frac{(1-\beta_x)[\overline{r} + \gamma_\pi \pi^* - \overline{\gamma} - (\gamma_\pi - 1)\pi_0]}{2(\gamma_\pi - 1)(t + 1 - \beta_x t)} \tag{11}$$

$$+ \frac{(y_n - 1)\left(2\sum_{v=1}^{t+1} \mu_v - \xi_{i+1}\right) + \mu_{t+1} - \theta_x\left[(y_n - 1)\left(2\sum_{v=0}^{t} \mu_v - \xi_t\right) + \mu_t\right] - (a_x - y_x)(\theta_r \mu_t - \eta_{t+1})}{2(y_\pi - 1)(t + 1 - \beta_x t)}$$

Because η_t, μ_t, ξ_t are i.i.d. shocks with zero mean by assumption, then by taking expectations of both sides of equation (11),

$$\theta^G - \overline{r} = \frac{1 - \beta_x}{2(\gamma_\pi - 1)[t(1 - \beta_x) + 1]}[\overline{r} + \gamma_\pi \pi^* - \overline{\gamma} - (\gamma_\pi - 1)\pi_0].^8$$

Because $\overline{\gamma} = \pi^* + \overline{r}$,

$$\theta^G - \overline{r}\ \frac{1 - \beta_x}{2[t(1 - \beta_x) + 1]}(\pi^* - \pi_0), \tag{12}$$

The important implication of equation (12) is that, because $\frac{1-\beta_x}{[t(1-\beta_x)+1]} > 0$, then $\theta^G \leq \overline{r}$ if $\pi^* \leq \pi_0$ and $\theta^G > \overline{r}$ if $\pi^* > \pi_0$.[9] By equation (5), if $\theta^G \leq \overline{r}$ then inflation does not accelerate, but if $\theta^G > \overline{r}$ then inflation accelerates. Hence, equation (12) determines the rate of inflation in the model instead of equation (10) in the conventional model. Unlike the conventional model, the rate of inflation is determined not only by the target rate of inflation π^* but by the preference of government θ^G, *i.e.*, by interactions between the government and the monetary policy makers. If $\pi^* = \pi_0$, then $\theta^G = \overline{r} = \theta^P$ and inflation neither accelerates nor decelerates by equation (5), and therefore, in this case, equation (12) is equal to equation (10) in the conventional model such that $\lim_{s \to \infty} \pi_{t+s|t} = \pi^* = \pi_0$.

What should be stressed is that, unlike conventional models in which there is no possibility of the acceleration of inflation for any inflation target, there is a possibility that inflation accelerates for a range of inflation target, *i.e.*, inflation accelerates if the target rate of inflation is above an initial steady state inflation rate π_0. This possibility is the most important finding in the paper and plays the key role in the explanation for the cause of the Great Inflation that does not assume an exceptional situation in the next section.

The key mechanism for accelerating inflation lies in how people perceive θ^G by observing the rule of monetary policy. People can not observe the preference of government θ^G directly but can observe how monetary policy makers manipulate the short nominal interest rate. If people observe that monetary policy makers set an inflation target such that $\pi^* \leq \pi_0$, people perceive that $\theta^G \leq \overline{r}$ and thus inflation will not accelerate by equation (5). On the other hand, if people observe that monetary policy makers set an inflation target such that $\pi^* > \pi_0$, people perceive that $\theta^G > \overline{r}$ and thus inflation accelerates by equation (5).

IV. THE MECHANISM OF THE GREAT INFLATION

1. The Start of the Great Inflation

The cause of the Great Inflation is examined by the model with equation (5). Before the Great Inflation, *i.e.*, early in the 1960s, the rate of inflation was roughly 0.01 annually. Hence, it does not seem unnatural to assume that an initial steady state inflation rate is that $\pi_0 = 0.01$. The target rate of inflation $\pi^* = 0.02$ is usually regarded as sufficiently low and natural. If monetary policy makers set an inflation target in this way, *i.e.*, set it low but above the prevailing low rate of inflation such that $\pi^* = 0.02 > \pi^* = 0.01$, then people perceive that $\theta^G > \overline{r}$ by equation (12) and thus inflation accelerates by equation (5). That is, there is a possibility that even if a low inflation target is set, inflation accelerates. Even if monetary policy makers believe that the target rate of inflation is sufficiently low, there is a possibility that people perceive that $\theta^G > \overline{r}$ and inflation gradually picks up by equation (5). If a government does not actively oppose this behavior of monetary policy makers, people will perceive that the government allows this inflation target and overlooks $\theta^G > \overline{r}$.

This gradually picking up process is consistent with the observed gradually accelerated inflation in the 1960s. Hence, it can be argued that the monetary policy makers in the 1960s initially made an honest mistake to set the target rate of inflation slightly above the prevailing low rate of inflation, because they did not sufficiently understand the acceleration mechanism

of inflation argued above and thus believed that the target rate of inflation was sufficiently low. In addition, the economic theory prevailing at the time seems to have had a great influence on their behavior. Taylor (2002) argues that the idea — developed in the 1960s — that there was a long-run tradeoff between inflation and employment contributed greatly to the Great Inflation. Probably this idea tempted the monetary policy makers to set a slightly higher inflation target and the government to allow this inflation target.

2. The Acceleration of Inflation and Forced High Inflation Target Rates

In addition to the picking up process of the Great Inflation, the model in the paper can offer an explanation for the observed high target rate of inflation during the Great Inflation: once inflation accelerated owing to the acceleration mechanism of inflation, the target rate of inflation π^* needs to be raised accordingly by equation (12) unless the preference of government θ^G is changed downwards sufficiently. If θ^G is not changed, $\theta^G - \overline{r}$ = a positive constant for any period. This means that, unless the target rate of inflation π^* is raised gradually as inflation rises, equation (12) can not be held. By equation (12),

$$\theta^G - \overline{r} = \lim_{t \to \infty} \frac{1-\beta_x}{2[t(1-\beta_x)+1]}(\pi^* - \pi_0) = \lim_{t \to \infty} \frac{\pi^*}{2t}, \text{ and thus}$$

$$\lim_{t \to \infty} \frac{\pi^*}{2t} = \text{a positive constant.} \tag{13}$$

Hence, without raising the target rate of inflation π^* gradually as time passes, equation (13) and thus equation (12) can not be held. That is, unless the preference of government θ^G is changed downwards sufficiently, monetary policy makers must continue to raise the target rate of inflation gradually, *i.e.*, the target rate of inflation π^* is a time-variable endogenous variable while the preference of government θ^G is an exogenous variable in this case, which means that the monetary policy makers are not independent of the government in this case. Many researchers report that the target rate of inflation in the period of the Great Inflation was significantly high.[10] As was mentioned in introduction, it is hard to explain the reason for this unbelievable action taken by the monetary policy makers by the existing views argued in introduction unless contending that they deliberately committed a crime of high inflation. However, the model in the paper indicates that the monetary policy makers did not willingly set the high target rate of inflation but were forced to raise it to hold equation (13) because the governments did not change its preference downwards sufficiently.

3. The Necessity of Drastic Policy Change to Bring Down High Inflation

The explanation, however, is not completed. Another question may be raised: why wasn't the preference of government θ^G changed downwards sufficiently? As Meltzer (2005) argues, the policy makers in the U.S. began anti-inflation policies as early as 1966 and several times after — 1969, 1973, 1978-79, and 1980. Before answering this question, the way to bring down inflation is examined. First, consider a type of monetary policies that the target rate of inflation π^* is not raised enough to hold equation (13) $\lim_{t \to \infty} \frac{\pi^*}{2t}$ = a positive constant. With this type of

monetary policy, $\lim_{t \to \infty} \frac{\pi^*}{2t} = 0$. Hence, this manipulation of inflation target needs to accompany government's gradual downward revisions of its preference θ^G to the point $\theta^G = \overline{r}$. Thereby, eventually $\theta^G = \overline{r}$ and inflation stabilizes.[11] This type of manipulation — raising the target rate of inflation gradually but not enough to hold equation (13) — seems to correspond to the "gradualism" that is regarded as the typical behavior of the monetary policy makers at the time. However, this type of manipulation has a serious drawback that, during the transition period to the point $\theta^G = \overline{r}$, the preference of government θ^G continues to be over $\overline{r}$ and thus inflation continues to accelerate and the target rate of inflation must continue to be raised. Hence, although inflation stabilizes eventually, this stabilized rate of inflation will be very high and stay very high forever.

To bring down inflation — not to stabilize inflation at high rates, the target rate of inflation π^* must be reset to satisfy $\pi^* < \pi_0$. By this action, the sign of the term $\frac{1-\beta_x}{2[t(1-\beta_x)+1]}(\pi^* - \pi_0)$ in equation (12) immediately turns negative and thereby $\theta^G < \overline{r}$. What should be stressed is that, to bring down an already accelerated high inflation, the target rate of inflation π^* must be lowered drastically — not gradually. Accordingly, the nominal interest rate must be raised drastically by equation (3). It is because an already accelerated high inflation accompanies an already highly raised inflation target by equation (13) and thus the target rate of inflation must be lowered drastically to achieve $\pi^* < \pi_0$. To drastically lower the target rate of inflation π^*, the government simultaneously must drastically lower its preference θ^G because equation (12) can not hold unless θ^G is drastically lowered. Drastically lowering the target rate of inflation will make people perceive that the government and the monetary policy makers coordinated to reset the preference of government θ^G to the drastically lower one that satisfies $\theta^G < \overline{r}$. If people successfully turn convincing that $\theta^G < \overline{r}$, the rate of inflation will begin to decrease by equation (5). As is well-known, the policy of high nominal interest rate was taken in the 1980s and it successfully achieved a sharp disinflation. This fact is perfectly consistent with the mechanism explained above and thus this well-known monetary policy change in the late 1970s seems to be a typical case of this kind of drastic policy change.[12]

4. A Vicious Cycle: The Hesitation in Taking Drastic Actions and the Acceleration of Inflation

The above analysis implies that the question why the preference of government θ^G was not changed downwards sufficiently is equivalent to a question why the governments in the 1960s and the 1970s took so long time to drastically change policies. An easy answer is that it took time for them to fully understand the acceleration mechanism of inflation.[13] However, it does not seem likely that they were so foolish that they did not doubt the prevailing economic idea throughout the 1970s. Rather, the key to the question seems to lie in the very natures of the Great Inflation uncovered in the paper, particularly the necessity of drastic — not gradual — policy change and the acceleration mechanism of inflation.

Firstly, even though a government fully recognizes the necessity of drastic policy change, the government will be hesitant to this drastic change of policy because drastic policy changes usually accompany high risks/uncertainties, both economic and political. In particular, if it is

the first experience, risks/uncertainties will be perceived much higher owing to the lack of information on the outcome of such a drastic change. The governments and the monetary policy makers in the 1970s never experienced a peacetime chronic high inflation before and the Great Inflation was the first experience for them to be required to change policies drastically to bring down inflation. In addition, the idea — although many were increasingly half in doubt in the 1970s — that there was a long-run tradeoff between inflation and employment may have exaggerated the seriousness of the outcome of a drastic policy change to some extent and increased economic and political risks/uncertainties the governments perceived. Probably the governments did not expect the acceleration of inflation because initially they did not sufficiently understand the acceleration mechanism of inflation, but once inflation accelerated unexpectedly by the error explained above, they could not correct the error any longer because they were afraid of the risks/uncertainties that the necessary drastic actions would generate. As a whole, even if the governments recognized the necessity of drastic policy change to bring down the unexpectedly accelerated rate of inflation early in the 1970s, the governments would have felt facing significant economic and political risks/uncertainties and would have hesitated to take such drastic actions.

Secondly, the acceleration mechanism of inflation explained in the paper seems to have exaggerated the situation. By equation (12), inflation continues to accelerate unless drastic actions are taken. If a government hesitates to take drastic actions and instead continues to take "gradualism" actions owing to the above mentioned reasons, inflation accelerates by equation (12) and the rate of inflation becomes much higher during the hesitation. This higher rate of inflation will make the government perceive much higher risks/uncertainties because much more drastic actions are needed. Then the government will continue to hesitate. A vicious cycle is generated. It seems likely that during the Great Inflation, this kind of vicious cycle was generated and the governments and the monetary policy makers could not get away from "gradualism."

In short, the governments and the monetary policy makers in the 1970s continued to take "gradualism" actions — raising the target rate of inflation gradually but not enough to hold equation (13) — and needed time to take drastic actions to bring down inflation probably because the very natures of the Great Inflation hindered the governments in taking drastic actions, *i.e.*, firstly, the government was made hesitant owing to the necessity of drastic actions that accompanied high economic and political risks/uncertainties that were felt higher by the lack of experience and by the idea that there was a long-run tradeoff between inflation and employment, and secondly, a vicious cycle was generated owing to the acceleration mechanism of inflation.

5. The Mechanism of the Great Inflation

To sum up, the explanation for the cause of the Great Inflation based on the model contends that the monetary policy makers in the 1960s and the 1970s did not continue to be insincere or foolish and internationally common large or successive negative supply shocks were irrelevant, but the Great Inflation was a consequence of policy errors that were made in the process of interaction between the governments and the monetary policy makers such that (i) despite the possibility that inflation accelerates even for a low inflation target by the acceleration mechanism of inflation, the monetary policy makers in the 1960s made an honest mistake to set a slightly

higher inflation target than the prevailing low rate of inflation because initially they lacked the sufficient understanding of the acceleration mechanism and because the idea that there was a long-run tradeoff between inflation and employment tempted the monetary policy makers to set a slightly higher inflation target and the government to allow this inflation target, (ii) after inflation picked up, the monetary policy makers were forced to raise the target rate of inflation unwillingly owing to the acceleration mechanism of inflation, because the governments were made hesitant, and (iii) the governments were hesitant because a drastic policy change to bring down the unexpectedly accelerated rate of inflation was needed, which accompanied high economic and political risks/uncertainties that were exaggerated by the lack of experience and by the idea that there was a long-run tradeoff between inflation and employment. Furthermore, the acceleration mechanism of inflation exaggerated the situation by having generated a vicious cycle.

The acceleration mechanism of inflation seems to have another effect than it generates a vicious cycle. As inflation accelerates by the acceleration mechanism of inflation, more people will reach a conclusion that the incumbent government should be replaced because a drastic policy change is necessary and the vicious cycle should be severed. When the people who have this opinion gain a majority, drastic actions will be taken by a replaced government. Taylor (2001, 2002) emphasizes the importance of changes in economic and political leadership as a cause of the Great Inflation by quoting Milton Friedman. He argues that the Great Inflation was fundamentally political, not economic, phenomenon and what ended the Great Inflation was Ronald Reagan who accepted a severe recession without bringing pressure on the Fed to reverse course.[14] The model in the paper and the explanation for the cause of the Great Inflation by the model is completely consistent with this view.

V. DISCUSSION

The essence of this explanation lies in the acceleration mechanism of inflation, *i.e.*, equation (5). All the other views argued in introduction assume implicitly homogeneity $\theta^G = \theta^P = \overline{r}$ and thereby inflation does not normally accelerate and will be soon stabilized even if it deviated unless assuming an exceptional situation as was shown in equation (10). On the other hand, the model in the paper allows possibilities of heterogeneity $\theta^G \neq \theta^P = \overline{r}$, and therefore the acceleration and deceleration of inflation is generated without assuming an exceptional situation.

The above characteristics of the model in the paper seem to be the great advantage of the model over other models. In particular, the explanation in the paper has the following appealing features. First, it does not need to assume that the monetary policy makers at the time were unbelievably insincere or foolish. The time inconsistency view and the policy mistake views imply that the monetary policy makers in those days continued to be insincere or foolish for a long period of time. However, many will not agree on this conjecture easily.[15] The explanation in the paper also does not stand for these views. Of course, the monetary policy makers should be blamed for initially having made an honest mistake to set a slightly higher inflation target probably because they lacked the sufficient understanding of the acceleration mechanism and because the idea that there was a long-run tradeoff between inflation and employment tempted them to set it so. However, the paper argues that the following policy errors were made in the process of interaction between the governments and the monetary policy makers. A problem

was that the governments were made hesitant to take drastic actions because they perceived high economic and political risks/uncertainties that the necessary drastic policy change would generate. In addition, the acceleration mechanism of inflation exaggerated the situation by having generated a vicious cycle. The paper therefore argues that the policy errors made during the Great Inflation were not so simple to be attributed solely to the insincerity or foolishness of the monetary policy makers. Hence, this explanation seems more natural than explanations that merely assume that the monetary policy makers continued to be insincere or foolish for a long period of time.

Secondly, the view in the paper can explain a mechanism of the observed high target rate of inflation. Setting a high inflation target indicates that monetary policy makers commit a crime of high inflation deliberately. Other views argued in introduction clearly have no other way to accept this notion. The paper, however, uncovered a mechanism by which the monetary policy makers in those days were forced to raise the target rate of inflation unwillingly owing to the acceleration mechanism of inflation because the governments were made hesitant. According to the view, the monetary policy makers did not commit a crime of high inflation deliberately but had no other option unless the governments took high risks/uncertainties and dared to take necessary drastic actions. This explanation clearly seems more natural than other explanations that need to accept the notion that the monetary policy makers deliberately committed a crime of high inflation.

Thirdly, the explanation has an appealing feature such that it is able to explain the international aspect of the Great Inflation without assuming internationally common large or successive negative real shocks. The shock based views, *i.e.*, the bad luck view, the time inconsistency view and the weak response view, need a common shock across countries to explain the international aspect of the Great Inflation. Some may argue that the oil price shock in 1973 was just the shock that was experienced simultaneously in most industrialized countries. However, the Great Inflations already started in the mid-1960s in many industrialized countries and thus the initial shock can not be attributed to the oil price shock in 1973. Hence, the shock based views are facing difficulty to explain the international aspect of the Great Inflation. On the other hand, the explanation in the paper does not need such shocks but concerns only the attitudes of the government and the monetary policy makers. It seems likely that the governments and the monetary policy makers in those days in most industrialized countries assumed a common attitude respectively because the economic policies conducted in the U.S. were imitated by other countries. Hence, the view presented in the paper is consistent with the international aspect of the Great Inflation, while the shock based views are inconsistent.

VI. CONCLUDING REMARKS

There are many explanations for the cause of the Great Inflation, and most of them seem to be classified into several views: (i) the bad luck view, (ii) the time inconsistency view, (iii) the policy mistakes views (the weak response view and the misperception view). These views appear very different each other, but they have some common features. First, except the bad luck view, they commonly argue that the monetary policy makers in the 1960s and 1970s continued to be insincere or foolish for a long period of time, and secondly, except the misperception view, they need exceptionally large or successive internationally common negative real shocks.

The paper explored a different possibility of explanation that does not need to assume such an exceptional situation. The model in the paper explicitly incorporates the preference of government and considers not only the behavior of monetary policy makers but the behavior of government. Unlike conventional models, in which the role of government is not explicitly separated from the role of monetary policy makers and the relation between them is left ambiguous, the model in the paper explicitly separates the roles of them and can analyze the process of decision makings through interactions between them. It was shown that the model in the paper has a completely different feature from conventional models: inflation accelerates for a range of inflation target, while conventional models predict that inflation does not accelerate unless an exceptional situation is assumed. This feature is the most important finding in the paper and plays the key role in the explanation for the cause of the Great Inflation that does not assume an exceptional situation.

The paper argues that the Great Inflation was a consequence of policy errors that were made in the process of interaction between the governments and the monetary policy makers, and the cause of the Great Inflation is explained such that (i) despite the possibility that inflation accelerates even for a low inflation target by the acceleration mechanism of inflation, the monetary policy makers in the 1960s made an honest mistake to set a slightly higher target rate of inflation than the prevailing low rate of inflation because initially they lacked the sufficient understanding of the acceleration mechanism of inflation and because the idea that there was a long-run tradeoff between inflation and employment tempted the monetary policy makers to set a slightly higher inflation target and the government to allow this inflation target, (ii) after inflation picked up, the monetary policy makers were forced to raise the target rate of inflation unwillingly owing to the acceleration mechanism of inflation, because the governments were made hesitant, and (iii) the governments were hesitant because a drastic policy change to bring down unexpectedly accelerated inflation was needed, which accompanied high economic and political risks/ uncertainties that were exaggerated by the lack of experience and by the idea that there was a long-run tradeoff between inflation and employment. Furthermore, the acceleration mechanism of inflation exaggerated the situation by having generated a vicious cycle.

The explanation in the paper has three appealing features. First, it does not need to assume the unbelievable insincerity or foolishness of the monetary policy makers at the time. The monetary policy makers should be blamed for initially having made an honest mistake. However, the following errors were made in the process of interaction between the governments and the monetary policy makers. The paper argues that the errors made during the Great Inflation were not so simple to be attributed solely to the insincerity or foolishness of the monetary policy makers. Secondly, the paper can explain the reason for the observed high target rate of inflation. It uncovered a mechanism by which the monetary policy makers at the time were forced to raise the target rate of inflation unwillingly because of the hesitation of the government to take drastic actions. Hence the explanation does not need to accept the notion that the monetary policy makers deliberately committed a crime of high inflation. Thirdly, the explanation can explain the international aspect of the Great Inflation without assuming internationally common large or successive negative real shocks. It concerns only the attitudes of the government and the monetary policy makers. The attitudes of them seem to have been similar across countries because the economic policies conducted in the U.S. were imitated by other countries.

Finally, the end of the Great Inflation is explained as follows. As inflation accelerates by the acceleration mechanism of inflation, more people will reach a conclusion that the incumbent government should be replaced because a drastic policy change is necessary and the vicious cycle should be severed. When the people who have this opinion gain a majority, drastic actions will be taken by a replaced government. Taylor (2001, 2002) emphasizes by quoting Milton Friedman that what ended the Great Inflation was Ronald Reagan who accepted a severe recession without bringing pressure on the Fed to reverse course. The model in the paper and the explanation for the cause of the Great Inflation by the model is completely consistent with this view.

Notes

1. See *e.g.*, Blinder (1982).
2. See *e.g.*, Clarida, Gali, and Gertler (2000) and Taylor (2002).
3. See also Christiano and Gust (2000).
4. See *e.g.*, Taylor (2002).
5. See *e.g.*, Mankiw (2001) and Holden and Driscoll (2003).
6. Clarida *et al.*, (2000) admit that their paper does not answer one important question: why is it that during the pre-1979 period the Federal Reserve followed a rule that was clearly inferior?
7. See Orphanides and Williams (2003).
8. Note that either the target rate of inflation π^* or the preference of government θ^G is a time-variable endogenous variable. For instance, if the target rate of inflation π^* is a time-variable endogenous variable, π^* in equation (11) means $\pi^*_{t|0}$.
9. Note again that either π^* or θ^G is a time-variable endogenous variable.
10. See *e.g.*, Clarida *et al.*, (2000), Favero and Rovelli (2001) and Dennis (2001).
11. That is, a transition process from the initial steady state inflation rate π_0 to the new one π_0' — initiated by a shock on π^* — ends.
12. Once inflation is lowered, in order to keep it low, it is necessary that the target rate of inflation π^* is kept to be the one that satisfies $\pi^* = \pi_0$ and thus that the equation $\theta^G = \overline{r}$ is kept.
13. Taylor (2002) emphasizes the gradual learning process of new economic ideas.
14. Meltzer (2005) also emphasizes the large role of political decision making during the Great Inflation and concludes that the Federal Reserve was better able to control inflation when the President was named Eisenhower or Reagan instead of Johnson, Carter, or Nixon.
15. Delong (1997) and Taylor (2002) argue that policymakers and academic economists learned about the economy only gradually. Meltzer (2005), on the other hand, argues that he does not believe that either the start of inflation or the 15 years that followed can be explained fully as a consequence of errors in the economic theory that the FOMC applied.
16. The constraint is equivalent to $\dot{k}_t = f(k_t) - r_t - \dot{b}_t - x_t - s_t + b_t(R_t - \pi_t)$.
17. As for the Leviathan government, see, *e.g.*, Brennan and Buchanan (1980).
18. See Harashima (2004).

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APPENDIX

A.1 A Model of Inflation that Explicitly Incorporates the Preference of Government

Governments pursue their political objectives, *e.g.*, strengthening national security, improving social welfare, or enhancing national prestige. The utility function of such a government is $u^G(g_t, x_t)$, where g_t is the real government expenditure, x_t is the real tax revenue, $\frac{\partial u^G}{\partial g_t} > 0$, $\frac{\partial^2 u^G}{\partial g_t^2} < 0$, $\frac{\partial u^G}{\partial x_t} < 0$, and $\frac{\partial^2 u^G}{\partial x_t^2} > 0$. All variables are expressed in per capita terms. It is assumed that u^G is a constant relative risk aversion utility function. The government's rate of time preference is θ^G. The tax is assumed to be lump-sum. The budget constraint of the government is

$$\dot{B}_t = B_t R_t + G_t - X_t - S_t$$

where B_t is the accumulated nominal government bonds, R_t is the nominal interest rate for government bonds, and S_t is the nominal amount of seigniorage in period t. R_t is composed of the real interest rate r_t and the expected change of bonds' price by inflation $\pi^e_{b,t}$, such that $R_t = r_t + \pi^e_{b,t}$. Let $b_t = \frac{B_t}{p_t}$ and $s_t = \frac{S_t}{p_t}$, and $\pi_t = \frac{\dot{P}_t}{p_t}$ is the inflation rate in period t. By divided by p_t, the budget constraint is transformed to

$$\frac{\dot{B}_t}{p_t} = b_t R_t + g_t - x_t - s_t ,$$

and it is equivalent to

$$\dot{b}_t = b_t R_t + g_t - x_t - s_t - b_t \pi_t = b_t (R_t - \pi_t) + g_t - x_t - s_t .$$

Hence, the optimality problem of the government is

$$\text{Max } E_0 \int_0^\infty u^G(g_t, x_t) \exp(-\theta^G t)\, dt$$

subject to

$$\dot{b}_t = b_t (R_t - \pi_t) + g_t - x_t - s_t .$$

On the other hand, a representative household maximizes the following expected utility:

$$\text{Max } E_0 \int_0^\infty u^P(c_t) \exp(-\theta^P t)\, dt$$

where u^P and θ^P are the utility function and the rate of time preference of the representative household, subject to the following constraint:

$$\dot{k}_t = f(k_t) - c_t - g_t ,$$

where $f(\cdot)$ is the production function, k_t is the real capital per capita, and c_t is the real consumption per capita.[16] The constraint means that the output $f(k_t)$ in each period is demanded for the private consumption c_t, the private investment $\dot{k}_t$ and the government expenditure g_t. The government expenditure g_t is an exogenous variable for the representative household because the government is a Leviathan.[17] It is assumed that $u^{P'} > 0$ and $u^{P''} < 0$ and the number of population is constant.

A.2 The Law of Motion for Price

The optimality conditions of both government and representative household yield the following important and clear-cut results, which are inevitable consequences of heterogeneity between a government and households.

Theorem 1: $\pi^e_{b,\,t} = \pi_t + \theta^G - \theta^P$, at the steady state such that $\dot{g}_t = 0$, $\dot{x}_t = 0$, $\dot{c}_t = 0$ and $\dot{k}_t = 0$.

Proof: Let Hamiltonian H be

$H = u^G(g_t, x_t) \exp(-\theta^G_t) + \lambda_t [b_t(R_t - \pi_t) + g_t - x_t - s_t]$ where λ_t is a costate variable.

The optimality conditions of the government's above problem are

(a1) $$\frac{\partial u^G(g_t, x_t)}{\partial g_t} \exp(-\theta^G t) = -\lambda_t ,$$

(a2) $$\frac{\partial u^G(g_t, x_t)}{\partial x_t} \exp(-\theta^G t) = \lambda_t ,$$

(a3) $$\dot{\lambda}_t = -\lambda_t (R_t - \pi_t) ,$$

(a4) $$\dot{b}_t = -b_t (R_t - \pi_t) + g_t - x_t - s_t ,$$

(a5) $$\lim_{t \to \infty} \lambda_t b_t = 0.$$

Combining conditions (a1), (a2) and (a3) yields the following equations:

$$\frac{g_t \dfrac{\partial^2 u^G(g_t, x_t)}{\partial g_t^2}}{\dfrac{\partial u^G(g_t, x_t)}{\partial g_t}} \frac{\dot{g}_t}{g_t} + \theta^G = R_t - \pi_t = r_t + \pi^e_{b,\,t} - \pi_t ,$$

and

$$-\frac{x_t \dfrac{\partial^2 u^G(g_t, x_t)}{\partial g_t^2}}{\dfrac{\partial u^G(g_t, x_t)}{\partial x_t}} \frac{\dot{x}_t}{x_t} + \theta^G = R_t - \pi_t = r_t + \pi^e_{b,\,t} - \pi_t .$$

Here, $\frac{g_t \frac{\partial^2 u^G(g_t, x_t)}{\partial g_t^2}}{\frac{\partial u^G(g_t, x_t)}{\partial g_t}} \frac{\dot{g}_t}{g_t} = 0$ and $\frac{x_t \frac{\partial^2 u^G(g_t, x_t)}{\partial x_t^2}}{\frac{\partial u^G(g_t, x_t)}{\partial x_t}} \frac{\dot{x}_t}{x_t} = 0$ at the steady state such that $\dot{g}_t = 0$, and $\dot{x}_t = 0$, and thus $\theta^G = r_t + \pi^e_{b,t} - \pi_t$.

Here, by the optimality conditions of the representative household, $r_t = \theta^P$ at the steady state such that $\dot{c}_t = 0$, $\dot{k}_t = 0$ and $\dot{g}_t = 0$.

Hence $\theta^G = \theta^P + \pi^e_{b,t} - \pi_t$, and thus $\pi^e_{b,t} = \pi_t + \theta^G - \theta^P$ at the steady state such that $\dot{g}_t = 0$, $\dot{x}_t = 0$, $\dot{c}_t = 0$ and $\dot{k}_t = 0$.

Q.E.D.

This theorem is the natural consequence of simultaneous optimization by a government and households. What should be stressed is that $\pi^e_{b,t} \neq \pi_t$, if the rates of time preference are heterogeneous between government and representative household. Some may be embarrassed by the result $\pi^e_{b,t} \neq \pi_t$, because it has been naturally conjectured that $\pi^e_{b,t} = \pi_t$, under rational expectations. However, theorem 1 indicates that it holds only under a special assumption such that $\theta^G = \theta^P$, *i.e.*, the homogeneous rate of time preference. Probably because the homogeneous rate of time preference such that $\theta^G = \theta^P$ has been regarded as naturally prevailing, nobody may have questioned the equation $\pi^e_{b,t} = \pi_t$. However, the homogeneous rate of time preference is not guaranteed usually.[18] If there are heterogeneous rates of time preference between a government and households such that $\theta^G \neq \theta^P$, theorem 1 indicates that the equation $\pi^e_{b,t} = \pi_t$, can not hold anymore.

What does the equation $\pi^e_{b,t} = \pi_t + \theta^G - \theta^P$, indicate? It indicates that inflation accelerates/decelerates. Without acceleration/deceleration of inflation, the equation $\pi^e_{b,t} = \pi_t + \theta^G - \theta^P$, can not hold if $\theta^G \neq \theta^P$. That is, inflation accelerates/decelerates as a result of reconciling the contradiction in heterogeneous rates of time preference. To understand this mechanism more clearly, the following additional assumptions are introduced. Under these assumptions, *i.e.*, (i) a price change of bonds during a period is equal to the general price change during the period and (ii) perfect foresight, the equation $\pi^e_{b,t} = \pi_t + \theta^G - \theta^P$, determines the path of rates of inflation and thus depicts the basic law of motion for price.

Assumptions:

(A1) The expected change of bonds' price by inflation $\pi^e_{b,t}$, in period t is formed by expected inflation rates in period t such that $\pi^e_{b,t} = E_t \int_t^{t+1} \frac{\dot{p}_v}{p_v} dv = E_t \int_t^{t+1} \pi_v dv$ where E_t is the expectation operator.

(A2) Expected inflation rates are perfectly realized and thus $\int_t^{t+1} \pi_v dv = \pi^e_{b,t} = E_t \int_t^{t+1} \pi_v dv$.

Assumption (A1) means that the expected change of bonds' price by inflation $\pi^e_{b,t}$, equals the expected general price change during period t, and because R_t is based on the budget constraint of the government $\dot{B}_t = B_t R_t + G_t - X_t - S_t$, assumption (A1) is quite natural one. Assumption (A2) simply assumes rational expectations and perfect foresights.

The basic law of motion for price under these assumptions is described in the following theorem 2. However, to yield theorem 2, we need a few lemmas and corollary.

Corollary 1: $R_t - \pi_t = \theta^G$ at the steady state such that $\dot{g}_t = 0$, $\dot{x}_t = 0$, $\dot{c}_t = 0$ and $\dot{k}_t = 0$.

Proof: By theorem 1 and assumptions (A1) and (A2),

$\int_t^{t+1} \pi_v dv - \pi_t = \pi^e_{b,t} - \pi_t = R_t - r_t - \pi_t = \theta^G - \theta^P$, at the steady state such that $\dot{g}_t = 0$, $\dot{x}_t = 0$, $\dot{c}_t = 0$ and $\dot{k}_t = 0$. Hence, $R_t - \pi_t = \theta^G$. owing to $r_t = \theta^P$ at the steady state.

Q.E.D.

That is, the real interest rate for government bonds estimated using the current inflation rate is the time preference rate of the government.

Lemma 1: If and only if $\theta^G = -\frac{g_t - x_t - s_t}{b_t}$ at the steady state, then the transversality condition (a5) $\lim_{t\to\infty} \lambda_t b_t = 0$ holds.

Proof: Substituting the results of theorem 1 and corollary 1 into conditions (a3) and (a4) and solving both differential equations yield the equation: $\lambda_t b_t = -\exp\left[(g_t - x_t - s_t)\int \frac{1}{b_t} dt + C^{\#}\right]$ at the steady state where $C^{\#}$ is a certain constant. Thereby it is necessary to satisfy $g_t - x_t - s_t < 0$ and $\lim_{t\to\infty} \int \frac{1}{b_t} dt = \infty$ for the transversality condition (a5) to be held.

Here, by condition (a4), $\frac{\dot{b}_t}{b_t} = \theta^G + \frac{(g_t - x_t - s_t)}{b_t}$ at the steady state. Hence if $\frac{\dot{b}_t}{b_t} = \theta^G + \frac{(g_t - x_t - s_t)}{b_t} = 0$ at the steady state then b_t is constant and thus $\lim_{t\to\infty} \int \frac{1}{b_t} dt = \infty$. Thereby the transversality condition holds. However, if $\frac{\dot{b}_t}{b_t} = \theta^G + \frac{(g_t - x_t - s_t)}{b_t} < 0$ at the steady state then b_t diminishes to zero, then the transversality condition (a5) can not hold because $g_t - x_t - s_t < 0$. If $\frac{\dot{b}_t}{b_t} = \theta^G + \frac{(g_t - x_t - s_t)}{b_t} > 0$ at the steady state then $\lim_{t\to\infty} \frac{\dot{b}_t}{b_t} = \theta^G$ and thus b_t increases as time passes and $\lim_{t\to\infty} \int \frac{1}{b_t} dt = \frac{C^{\#\#}}{\theta^G}$ where $C^{\#\#}$ is a certain constant. Thereby the transversality condition (a5) also can not hold.

Q.E.D.

If the transversality condition is satisfied, then, at the steady state, the increase of government's debts $\theta^G b_t$, *i.e.*, the real interest rate of government bonds estimated using the current inflation rate θ^G times accumulated debts b_t, is equal to the amount of reduction of debts $-(g_t - x_t - s_t)$ in any period.

Inflation rates will not have seasonal cycles, and therefore the following assumption will be seen as quite natural.

Assumption: (A3) π_t does not have any cycle of length 1.

Lemma 2: If and only if $\pi_{t+\zeta} = \pi_t + 2\zeta(\theta^G - \theta^P)$, π_t does not have any cycle of length 1.

Proof: See Harashima (2004).

By the above lemmas and corollary, it is proved that under assumptions (A1), (A2) and (A3), the rate of inflation develops according to the following theorem.

Theorem 2: $\dot{\pi}_t = 2(\theta^G - \theta^P)$ at the steady state such that $\dot{g}_t = 0$, $\dot{x}_t = 0$, $\dot{c}_t = 0$ and $\dot{k}_t = 0$ if $\theta^G = -\frac{(g_t - x_t - s_t)}{b_t}$ at the steady state.

Proof: By theorem 1 and assumption (A1) and (A2), $\int_t^{t+1} \pi_v dv - \pi_t = \theta^G - \theta^P$ at the steady state such that $\dot{g}_t = 0$, $\dot{x}_t = 0$, $\dot{c}_t = 0$ and $\dot{k}_t = 0$. Thereby $\frac{d\pi_t}{dt} = \pi_{t+1} - \pi_t$.

Here, by lemma 2, $\pi_{t+1} = \pi_t + 2(\theta^G - \theta^P)$. Hence, $\frac{d\pi_t}{dt} = \pi_{t+1} - \pi_t = 2(\theta^G - \theta^P)$.

Q.E.D.

At first glance, this result may seem incredible, but the equation $\dot{\pi}_t = 2(\theta^G - \theta^P)$ appears quite natural because it indicates that $\dot{\pi}_t$ = constant, *i.e.*, inflation is significantly persistent, which is the essential nature of inflation.

Theorem 2 shows the consequence of heterogeneity in preferences between a government and households, *i.e.*, inflation plays a crucial role to reconcile the contradiction in the difference of time preference rates between a government and households. People are forced to reconcile the contradiction in time preference rates by expecting inflation because they know that the Leviathan government has no intention to be forced to default in any situation even if its budget constraint may not be satisfied.